Regional Anesthesia for Eye Surgery

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Ophthalmic surgery is the most frequent surgical procedure requiring anesthesia in developed countries. Nearly 2 million patients undergo cataract surgery each year in the United States.[1] Most procedures are performed under regional anesthesia. Eye blocks have long been limited to retrobulbar anesthesia performed by the surgeon with only monitored anesthesia care or no anesthesiologist assistance at all. Anesthesiologists are now increasingly involved in ophthalmic regional anesthesia. After changes in surgical practice because of the widespread use of the phacoemulsification technique, requests from the surgeon for total akinesia and lowered intraocular pressure have decreased. In the meantime, complications of the conventional retrobulbar anesthesia (RBA) technique have been extensively described, and the need for greater safety during eye block has been emphasized. This has resulted in the development of several emerging techniques intended to improve safety, even at the price of imperfect akinesia. These techniques may be useful for anterior segment surgery, especially cataract surgery. However, some surgeons still express a need for more efficient block, providing total globe akinesia and anesthesia of the globe for some surgical procedures (eg, posterior segment) and for some individual patients. A good knowledge of anatomy and of the various techniques will allow the anesthesiologist to choose the best block technique for each situation. This review will focus on the relevant anatomy, the classical (retro and peribulbar) needle block techniques along with their efficacy and complications, the emerging techniques and their relative interest and drawbacks, the choice of local anesthetics and adjuvant agents, and, finally, some continuing controversies.

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Anatomy

The orbit is a cavity exhibiting a truncated square pyramid shape, its apex posterior, and its base corresponding to the anterior aperture. The orbit is mainly filled by adipose tissue, and the globe is suspended in its anterior part. The 4 rectus muscles of the eye insert anteriorly near the equator of the globe. Posteriorly, they insert together at the apex on the Zinn tendinous annulus, through which the optic nerve enters the orbit. The 4 rectus muscles delimit the retrobulbar cone, which is not sealed by any intermuscular membrane.[2-5] The sensory innervation of the globe is supplied by the ophthalmic nerve (first branch of the trigeminal nerve [V]), which passes through the muscular cone. The trochlear nerve (IV) provides motor control to the superior oblique muscles, the abducens nerve (VI) to the lateral rectus muscle, and the oculomotor nerve (III) to all other extraocular muscles. All but the trochlear nerve pass through the muscular conus. Therefore, injecting local anesthetics inside the cone is logically expected to provide anesthesia and akinesia of the globe and of the extraocular muscles. Only the motor nerve to the orbicularis muscle of the eyelids has an extraorbital course, coming from the superior branch of the facial nerve (VII). Many major structures are located within the muscular conus and are therefore vulnerable to the risk of needlestick injury, including the optic nerve with its meningeal coverings, most arteries of the orbit, and the autonomic, sensory, and motor innervation of the globe. Therefore, some authors have proposed avoiding introducing a needle into the muscular cone and prefer to keep the needle in the extraconal space; this technique is theoretically less hazardous.[6,7] However, there is no extraconal space posterior to the globe because the rectus muscles are in contact with the bone walls of the orbit; thus, the extraconal space becomes virtual.

Tenon's capsule is a fibroelastic layer that surrounds the entire scleral portion of the globe, from the corneal limbus anteriorly to the optic nerve posteriorly. Its proper anatomic name is the facial sheath of the eyeball. It delimits a potential space named the episcleral space, often called the sub-Tenon's space. It has no actual volume, but fluid can be injected into it. It allows for globe rotation when changing gaze direction, and some authors liken it to the articular capsule of the globe. Near the equator, the Tenon's capsule is perforated by the tendons of the oblique and rectus muscles before they insert on the sclera. At this point, there is continuity between Tenon's capsule and the fascial sheath of the muscles. Anteriorly, Tenon's capsule fuses with the bulbar conjunctiva before they insert together on the corneal limbus.

Conventional Needle Block

Retrobulbar Anesthesia. *Principle.* Historically, RBA, which injects a small volume of local anesthetic agent (3-5 mL) inside the muscular cone, has been considered the gold standard of eye block. An additional facial nerve block is required to prevent blinking. Because of its extraconal motor control, the oblique superior muscle may frequently remain functional and thus elude total akinesia. The main hazard of RBA is the risk of injury of the globe or one of the many vulnerable elements located within the muscular cone. Near the apex, these structures are packed in a very small volume and are fixed by the tendon of Zinn, which prevents them from moving away from a needle. The resulting potential complications are detailed later.

Conventional Techniques. RBA was introduced toward the end of the 19th century. Since its formal description by Atkinson,[8] the conventional RBA technique has not changed for decades. The patient is asked to look in the "up and in" direction. The needle is introduced through the skin below the inferior lid at the junction between the lateral third and the medial two thirds of the inferior orbital edge. It is directed to the apex of the orbit (slightly medially and cephalad) and advanced to a 25- to 35-mm depth. Two to 4 mL of local anesthetic solution is then injected. An additional facial nerve block is performed to prevent blinking; the technique most frequently used is the van Lindt block.[9]

Alternative Techniques. The Atkinson "up and in" position of the gaze was abandoned when Liu et al.[10] and Unsöld et al.[11] confirmed that it increased the risk of optic nerve injury. Indeed, this position places the optic nerve near the path of the needle. Moreover, it is stretched and can be injured easily by the needle rather than being pushed away. Alternative puncture sites and specially designed bent or curved needles were proposed, without gaining popularity.[12-14] RBA is used less today, at least in part, because of its complications.

Peribulbar Anesthesia. This old technique has been highlighted by the works of Bloomberg, Davis, and Mandel.[6,7,15,16]

Main Principle. To reduce the risk of injury to major structures in the intraconal space, peribulbar anesthesia (PBA) introduces the needle into the extraconal space, which appears less hazardous. The injected volume of local anesthetic is larger than for a RBA injection (usually 6-12 mL). A large volume is required to allow the local anesthetic to spread into the whole corpus adiposum of the orbit, including the intraconal space, where the nerves to be blocked are located. Additionally, such a large volume allows anterior spread to the lids, thus providing a block of the orbicularis muscle and avoiding the need for additional lid block.

The classical technique involves 2 injections. The first injection is inferior and temporal, the needle being introduced at the same site as for a retrobulbar injection, but with a smaller "up and in" angle. The second injection is superior and nasal between the medial third and the lateral two thirds of the orbital roof edge (Fig 1).

Many alternative techniques have been described, which cannot be extensively reported here. The evolution of peribulbar anesthesia may be summarized into a few guidelines.

1. Use of a single-injection technique. Because the space where the local anesthetic spreads is unique, increasing the injected volume is sufficient to provide efficient anesthesia without the need for a second injection. Comparative studies confirmed that the single-injection technique is as effective as the double-injection technique provided the injected volume is sufficient.[17] Moreover, as the first injection may distort anatomic landmarks, it has been suggested that a second injection may lead to complications more frequently than a single one.[18] A second injection should be performed only as a supplement when the first injection has failed to provide effective anesthesia.
2. Avoid the superior nasal site of puncture. At this level, the distance between the orbital roof and the globe is reduced, theoretically increasing the risk of globe perforation. Additionally, the superior oblique muscle may be injured by the needle. The inferior nasal puncture remains the gold standard. An alternative site of puncture for peribulbar anesthesia is the medial canthus (Fig 2). [19] The needle is introduced at the medial junction of the lids, nasal to the lacrimal caruncle, in a strictly

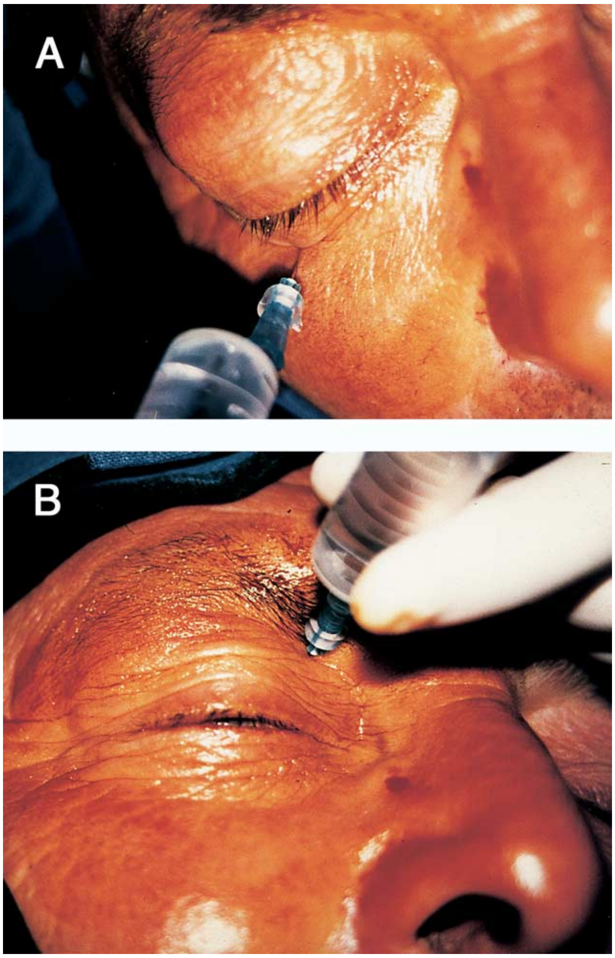

Fig 1. Conventional peribulbar injection: (A) inferior and temporal injection and (B) superior and nasal injection.

posterior direction, to ≤15 mm depth. At this level, the space between the orbital wall and the globe is similar in size to the inferior and temporal approach and is free from blood vessels. Moreover, myopic staphyloma, an anatomic anomaly that represents a risk factor for perforation, is infrequently located on the nasal side of the globe.

3. Limit needle insertion depth to 25 mm. Posterior to the globe, the rectus muscles are in contact with the orbital walls, so that the extraconal space totally disappears and becomes virtual. Increasing the depth of needle insertion would be expected to change a peribulbar into a retrobulbar injection.[20] Some posterior peribulbar blocks are in fact unintentional retrobulbar injections. This fact probably explains the occurrence of complications such as optic nerve injury after an attempted peribulbar injection. Moreover, a long needle fully introduced in the orbit may reach the apex of the orbit, which is a hazardous zone.[21] In an anatomic description, Katsev et al.[22] showed that inserting the needle up to a 40-mm depth would result in an injection directly through the optical foramen in 11% of cases.[22]
4. Use fine needles (25 gauge) to limit pain. The use of short-beveled needles may enhance security by increasing the tactile perception of resistance to be overcome during needle insertion. For example, short-bevel needles require more pressure to perforate the sclera on cadavers.[23] However, because of very low complication rates, a reduction of complication risks with the use of short bevel needles has not been shown.
5. Use compression to lower intraocular pressure, which increases after injection. Compression has not been shown to enhance the quality of the block. A 30 mm Hg pressure applied for 10 to 15 minutes is sufficient.

In all cases, the spread of local anesthetic within the corpus adiposum of the orbit remains somewhat unpredictable, leading to the need to increase the injected volume to prevent an imperfect block. Depending on the surgeon's request for akinesia, an additional injection is required between 1% and 50% of the cases.[15,16] This poor reproducibility in block efficacy is the main disadvantage of PBA.[6]

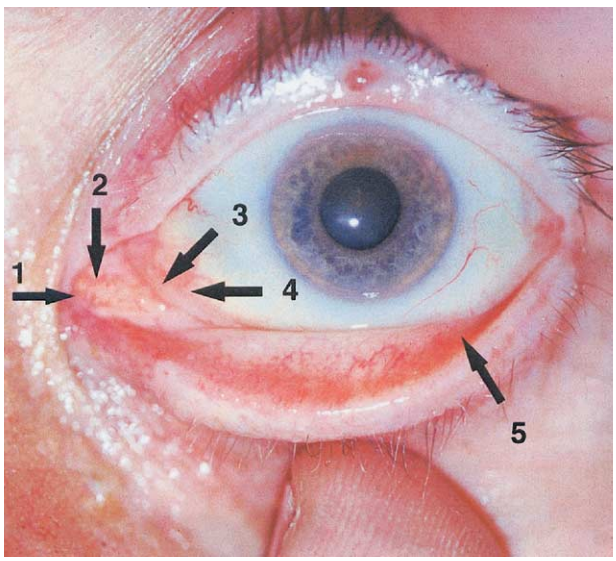

Fig 2. Site of introduction of the needle for the most frequently used blocks: (1) medial canthus peribulbar anesthesia,[19] (2) lacrymal caruncle, (3) semilunaris fold of the conjunctiva, (4) medial canthus episcleral anesthesia,[49,50] and (5) inferior and temporal peribulbar anesthesia.[6,7]

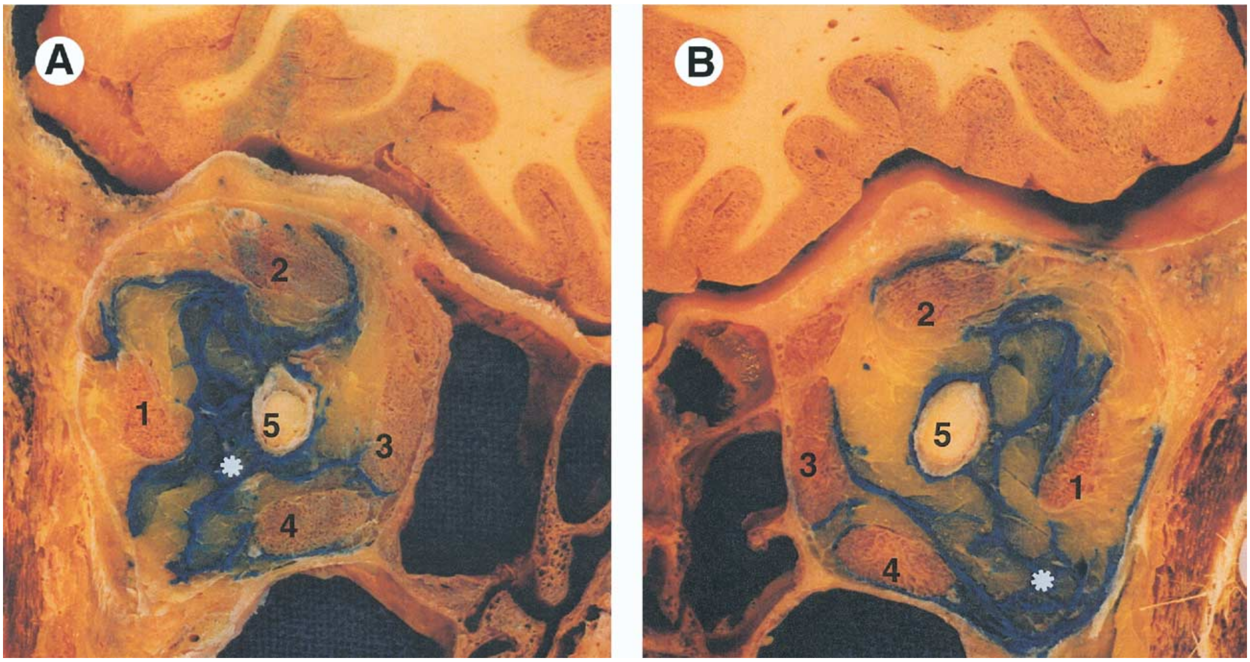

Fig 3. Spread of a latex dye simulating both retrobulbar (A) and peribulbar block (B) in 2 different eyes. Frontal sections passing just behind the globe, through the optic nerve: 1, lateral rectus muscle; 2, superior rectus muscle; 3, medial rectus muscle; 4, inferior rectus muscle; and 5, optic nerve. *Approximate location of the injection. Note that there is no evidence of any intermuscular membrane separating extra- from intraconal spaces and that, in both cases, the dye flows from one space to the other in all directions. (Reprinted with permission.[4])

The Retrobulbar Versus Peribulbar Controversy. RBA is classically assumed to be more efficacious than PBA. In fact, provided that a sufficient volume of local anesthetic is injected, PBA and RBA appear to have similar efficacies.[24] This can be explained by the fact that there is no intermuscular membrane to separate extra from intraconal spaces, both forming a unique space for spread of the local anesthetic (Fig 3).[2-5] If efficacy is similar, the only argument to prefer one technique to the other is safety. RBA, theoretically, carries a higher risk of complication because of the intraconal introduction of the needle (optic nerve injury, brainstem anesthesia, retrobulbar hemorrhage). However, the expected greater security of PBA has never been confirmed. The very low rate of complications and the subsequent lack of power of comparative studies can explain this lack of proven difference. To our opinion, similar efficacy and a probably higher risk of RBA makes PBA the preferable block.

Complication of Needle Blocks. The primary cause of complications is needle misplacement. Although some anatomic features may increase the risk of complications, the main risk factor is inadequate learning and limited experience of the physician who performs the block. Central nervous system spread of anesthesia may involve 2 mechanisms. First, an unintentional intra-arterial injection may reverse the blood flow in the ophthalmic artery up to the anterior cerebral or the internal carotid artery,[25] so that an injected volume as small as 4 mL can produce seizures. Symptomatic treatment usually allows rapid recovery without sequelae. Second, an unintentional injection under the dura mater sheath of the optic nerve or directly through the optic foramen may result in subarachnoid spread of the local anesthetic. This causes partial or total brainstem anesthesia.[26-28] Katsev et al.[22] has shown that the apex of the orbit may be reached with a 40-mm long needle in up to 11% of the patients.[22] Depending on the dose and volume of local anesthetic spreading toward the brainstem, a bilateral block or cranial nerve palsy with sympathetic activation, confusion, and restlessness, or a total spinal anesthesia with tetraparesis, arterial hypotension, bradycardia, and eventually respiratory arrest can occur. Symptomatic treatment should permit total recovery within hours (oxygen supply, vasopressors, and, if required, tracheal intubation and ventilation).

Unintentional globe perforation and rupture is the most devastating complication of eye blocks. It has a poor prognosis, especially in cases of delayed diagnosis. The incidence is between 1 of 350 and 7 of 50,000 cases.[29,30] Main risk factors include inadequate experience of the physician and a highly myopic eye (ie, long eyeball).[30] In a 50,000 case experience, Edge and Navon[29] observed that myopic staphyloma was the greater risk factor. This suggests that isolated high myopia may not be a risk factor per se but acts as a confounding factor because myopic staphyloma occurs only in myopic eyes.[29] Vohra and Good[31] have observed with B-mode ultrasound that the probability of staphyloma is greater in highly myopic than in slightly myopic eyes. Moreover, staphyloma was more frequently located at the posterior pole of the globe (accounting for perforations after retrobulbar anesthesia) or in the inferior area of the globe (accounting for perforations after inferior and temporal punctures, both peri- or retrobulbar). As a result, at least in myopic patients and at best in all patients, an ultrasound measurement of the axial length of the globe (biometry) should be available. In case of high myopic eye (axial length greater than 26 mm), the classical contraindication of eye block is still valid. However, it may be circumvented if B-mode ultrasound is performed to assess the presence and location of a staphyloma.

Injury to an extraocular muscle may cause diplopia and ptosis. Several mechanisms can be involved including direct injury by the needle resulting in intramuscular hematoma, high pressure because of injection into the muscle sheath, or myotoxicity of the local anesthetic.[32] The injury may progress in 3 steps: first, the muscle is paralyzed; second, it seems to recover; and third, a retractile scar develops.

Retrobulbar hemorrhage is caused by an inadvertent arterial puncture. It may lead to a compressive hematoma, which can threaten retinal perfusion. Surgical decompression may be required, but in most cases surgery has only to be postponed.[33] The main risk factor is arterial fragility (diabetes, atheroma) rather than hemostasis disorders. Venous puncture may occur after both retrobulbar and peribulbar injection. It leads to noncompressive hematoma, the consequences of which are much less severe, so that in most cases surgery can be carried on.

Direct optic nerve trauma by the needle is very rare but causes blindness. Computed tomography imaging usually shows optic nerve enlargement caused by intraneural hematoma.[21,34]

More Recent Techniques

Topical Anesthesia. Instillation of a local anesthetic eyedrop provides corneal anesthesia, thus allowing cataract surgery by phacoemulsification. It is quick and simple to perform and avoids the potential hazards of needle techniques. This technique is increasingly used for cataract surgery worldwide, up to 50% of procedure in some series.[1] Some surgeons prefer topical anesthesia for routine phacoemulsification in more than 90% of their cases. However, its efficacy is limited. The lack of akinesia and of intraocular pressure control, associated with its short duration, may make surgery hazardous.[35] Therefore, the use of topical anesthesia should be limited to uncomplicated procedures performed by experienced surgeons in cooperative patients. Whenever phacoemulsification is not possible, total akinesia is still required and topical anesthesia is questionable. This may be the case in world areas in which phacoemulsification is not technically available and in some specific indications.[36,37] Because anesthesia may be incomplete, patients randomly subjected to one of these techniques for one eye and the other technique for the other eye prefer the retrobulbar to the topical technique (71% vs 10%).[38] Intraoperative comfort is more constantly obtained under retrobulbar[35,38] or sub-Tenon's[39] than under topical anesthesia. Topical anesthesia appears to be no more effective than no anesthesia in selected cases for an experienced surgeon.[40] Intracameral injection of local anesthetic has been proposed to enhance analgesia.[41] It consists in injecting small local anesthetic amounts (0.1 mL) in the anterior chamber at the beginning of surgery. Some concerns have been expressed about local anesthetic toxicity effects on corneal endothelium, which is unable to regenerate. The safety of intracameral injection seems acceptable in this regard,[42] but its analgesic benefit versus simple topical anesthesia has not been established.[40,43-45] This is not surprising because analgesia is not correlated with intracameral local anesthetic concentration.[46] The insertion of sponges soaked in local anesthetic into the conjunctival fornices has been proposed.[47] The use of lidocaine jelly instead of eyedrops seems to enhance the quality of analgesia of the anterior segment[39,46,48] and is becoming very popular to improve the patient's comfort under topical anesthesia.

Perilimbal (Subconjunctival) Anesthesia. Subconjunctival injection of local anesthetic may provide analgesia of the anterior segment without akinesia. This technique has not gained popularity.

Episcleral (Sub-Tenon's) Blocks: Common Principle. Episcleral (sub-Tenon's) anesthesia, sometimes also called parabulbar anesthesia, places the injection into the episcleral space. This allows the local anesthetic to spread circularly all around the scleral portion of the globe, thus accounting for high-quality analgesia of the whole globe with relatively low volumes injected (usually 3-5 mL)

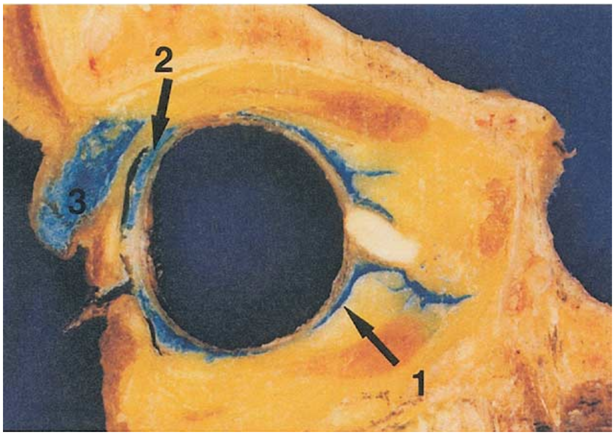

Fig 4. Spread of a dye injected into the episcleral (sub-Tenon's) space simulating episcleral anesthesia (small volume = 2mL), sagittal section. (1) Sub-Tenon's space filled by the dye spreading circularly all around the globe. The excess amount of dye flows subconjunctivally (2) and to the lids (3). (Reprinted with permission.[49] Clinical Anatomy © copyright 1998.)

(Fig 4).[49,50] In addition, the use of a larger volume (up to 8-11 mL) causes the local anesthetic to spread to the extraocular muscle sheaths, accounting for an effective and reproducible akinesia (Fig 5).[49-52] The occurrence of a chemosis (subconjunctival spread of the local anesthetic) is almost mandatory after injecting such large volumes. It confirms the sub-Tenon's location of the injection and requires compression to resolve itself. Several approaches have been described, including needle or no-needle surgical approaches.

Sub-Tenon's (Episcleral) Block: Needle Technique. The needle is introduced into the fornix between the semilunaris fold of the conjunctiva and the globe, tangentially to the globe (Fig 2).[49-51,53] After it has encroached the conjunctiva, the needle is slightly shifted medially and advanced strictly posteriorly, therefore attracting the globe and directing the gaze medially. After a small loss of resistance (click) is perceived, the globe comes back to its primary gaze position. This serves as a depth marker, thus indicating injection depth at 10 to 15 mm. The volume injected may be up to 10 mL, depending on the patient's anatomy.

Using a large volume with this technique (6-11 mL) results in good globe and eye lid akinesia that is more reproducible than classical peribulbar anesthesia.[51] This technique is simple to learn and use, with acceptable safety. In our 2,000 case experience, we have encountered no serious complication.[53] However, as for all needle techniques, the risk of misplacement of the needle and its subsequent complications must be kept in mind.

Sub-Tenon's (Episcleral) Block: Surgical Approach. This technique was first proposed as an intraoperative complement to poor or too short-lasting retrobulbar anesthesia.[54] It has gained some popularity after the demonstration of its efficacy as a sole anesthetic technique.[55] After topical anesthesia, the bulbar conjunctiva is grasped with a small forceps in the inferior and nasal, superior and nasal, or superior and temporal quadrant, 5 to 10 mm from the limbus. Blunt Wescott scissors are used to open a small buttonhole into the conjunctiva and Tenon's capsule to gain access to the episcleral space. A blunt canula is then inserted into the episcleral space to allow the injection. Several types of canulae have been proposed: smooth curved metallic canula, ultrashort metallic canula, silicon, or plastic canulae.[56,57] When no specific canula is available, a short intravenous catheter (18 or 20 gauge) without its needle can also be used.

This technique is typically used with injection of

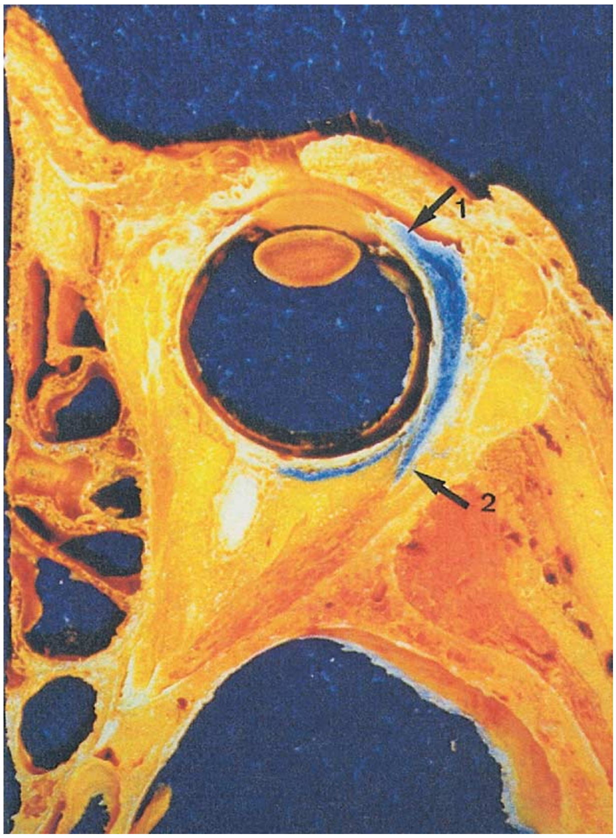

Fig 5. Spread of a dye injected into the episcleral (sub-Tenon's) space simulating episcleral anesthesia (large volume = 6 mL), horizontal section. Note the spread of the dye in the sub-Tenon's space circularly around the globe. The excess amount of dye flows subconjunctivally (1) and is guided into the lateral rectus muscle sheath (2). (Reprinted with permission.[49] Clinical Anatomy © copyright 1998.)

low volumes of local anesthetic (3-5 mL). This provides a good globe analgesia but only partial akinesia of the globe and lids. Its efficacy is excellent as regards globe anesthesia: 96% of the blocks were scored as perfect or good.[58] The use of small volumes causes a very limited increase of the intraocular pressure, so that preoperative compression of the globe may be unnecessary. In a same way, episcleral injection of a small volume of local anesthetic may be used on an open globe. Therefore, it is the technique of choice as an intraoperative supplemental injection when anesthetic technique appears insufficient during surgery. Increasing the injected volume up to 11 mL results in a good akinesia, allowing surgery of the posterior segment.[52] The main advantage of this technique is its safety because it avoids the blind introduction of a needle in the orbit. In a 6,000 case experience, Guise[58] reported no serious complication, and only 7% of subconjunctival hematoma without any consequence, and 6% of subconjunctival edema. Surgery cancellation because of subconjunctival hematoma occurred in only 1 case out of 6,000. The only disadvantage of this technique is the need for training anesthesiologists, who are frequently unfamiliar with this 2-hand technique.

Use of Eye Block in Postoperative Analgesia

Regional anesthesia and especially sub-Tenon's block have been proposed as a treatment for postoperative pain.[59] This is not required for anterior segment surgery, which is usually painless in the postoperative period. Actually, pain occurring after a cataract surgery is absolutely abnormal, and should be considered as an alarm sign of ocular hypertonia or sepsis. Postoperative pain may be greater after posterior segment surgery. The use of an indwelling retrobulbar, peribulbar, or sub-Tenon's catheter has been proposed for many years, both to improve intraoperative anesthesia, prolong postoperative regional analgesia, or to treat intractable eye pain.[60] However, it has limited indications in case of uncomplicated surgery.

Local Anesthetics and Adjuvant Agents

All available local anesthetics have been used for eye block, either alone or as a mixture of 2 agents. Many publications compared various local anesthetic mixtures and concentrations that cannot be detailed here. There is no definitive choice in terms of the ideal local anesthetic for eye block. The most often cited local anesthetics are lidocaine, bupivacaine, ropivacaine, mepivacaine, or a combination of 2 of these. The differences between those local anesthetic combinations are in accordance with their known pharmacological properties. Therefore, the choice of local anesthetics should be based on the pharmacological properties and availability of the drugs, mainly depending on the requirement for a quick onset (lidocaine, mepivacaine), prolonged effect or postoperative residual block for analgesia (ropivacaine, bupivacaine), and akinesia (higher concentration). Because the amount of local anesthetic injected is usually small (3-11 mL), systemic toxicity is not a major concern.

Hyaluronidase is an enzyme that facilitates a wider spreading of local anesthetics. It is therefore assumed to shorten the onset of the block and enhance its quality. However, the literature is somewhat controversial about its real benefit concerning akinesia.[61] This may be caused by varying concentrations in different studies. Doses varying from 3.75 to 300 IU/mL of local anesthetic have been reported, with a greater benefit at higher doses.[62] Given the wide range of concentrations used and the absence of clear dose-efficacy ranging, 25 to 50 IU/mL can be proposed. Other benefits of hyaluronidase include a smaller intraoperative intraocular pressure increase, which may dramatically hinder surgery.[62] The last benefit of hyaluronidase is its ability to decrease the incidence of postoperative strabismus, possibly by limiting local anesthetic myotoxicity because of a faster spread.[63,64]

Clonidine enhances intra- and postoperative analgesia when added to the local anesthetic. At a dose of 1 μg/kg, it does not increase the incidence of systemic adverse events such as hypotension or excessive sedation.[65] Moreover, it may help to prevent intraoperative arterial hypertension and lower intraocular pressure.

Epinephrine is sometimes used to increase the duration of eye block. However, the availability of long-acting local anesthetics has decreased its value. Fear of vasospasm and subsequent retinal ischemia is probably not justified because the local anesthetic mixture does not spread inside the globe where retinal arteries are located.

Alkalinization has been proposed to decrease pain during injection and accelerate the block onset, but it has limited efficacy. The optimal concentration of bicarbonate is difficult to determine because of the large pH range of local anesthetic solutions provided by pharmaceutical firms. Moreover, the local anesthetic may precipitate in case of excess alkalinization.[66]

Other adjuvant agents have been proposed but have not gained popularity. Small doses of muscle relaxant may enhance akinesia, but concern has been expressed about their potential risk for systemic effects.[67] Opioids do not appear to be more efficient via a regional ophthalmic route than via systemic administration.[68] Warming the local anesthetic may decrease pain on injection and enhance block efficacy, but its benefit appears clinically irrelevant.[69]

Controversies

Who Should Perform the Block? Since the 1980s, anesthesiologists have become increasingly involved in eye blocks that were previously performed by surgeons. However, they are very great differences in anesthesiologists' participation in eye blocks both between and within countries. In some places, anesthesiologists are not available, and surgeons have to manage the block themselves.[70] In other places, anesthesiologists provide only monitor anesthesia care as the surgeon performs the block. Finally, in many countries like France and the United Kingdom, anesthesiologists increasingly perform the block. Reports have emphasized complications after blocks performed by anesthetists,[71] although some were associated with blocks performed by nurses-anesthetists or operating room nurses directly supervised by surgeons. It must be emphasized that eye blocks are, like any other regional anesthesia, potentially dangerous but relatively safe. Anesthesiologists should theoretically be the most appropriate persons to perform blocks, provide monitored anesthesia care, and manage life-threatening complications. Provided that they have been correctly trained, anesthesiologists have shown their ability to perform eyes blocks as other regional anesthesia techniques.[12,19,53,58] The cost effectiveness of this practice may vary among various institutions, depending on the payment system.

Supporting Therapies. Eye surgery, especially cataract surgery, has very little impact on perioperative morbidity and mortality.[72-74] Eye block is associated to a trend toward a lower perioperative morbidity when compared with general anesthesia for ophthalmic surgery, provided that no heavy sedation is added.[73,74] Therefore, some standard precautions like monitoring, fasting, or preoperative evaluation, which are considered as basic recommendations for other types of block, are sometimes circumvented for eye block.[75] Preoperative fasting has been questioned before eye surgery under local anesthesia.[12] In case of complication, a full stomach may constitute a complicating factor. There is no evidence to claim that the usual fasting regimen is not required. Intraoperative monitoring should include basic monitoring (ie, electrocardiogram, pulse oxymetry, and automated noninvasive blood pressure measurement). An intravascular access is required. Elderly patients undergoing eye surgery frequently have coexisting diseases such as diabetes mellitus, hypertension, coronary artery disease, or cardiac insufficiency. Therefore, a preoperative assessment to ensure a proper control of coexisting disease appears well advised.

Anxiety and residual pain frequently occur during eye surgery under local anesthesia. Perfect immobility is required, and the presence of drapes over the head increases anxiety and impairs access to the airway. Therefore, the patient should be positioned as comfortable as possible, with sufficient space to allow free breathing. An additional fresh airflow is preferable to oxygen to reduce combustion hazard in a confined ambiance. Intraoperative sedation can be used to limit anxiety and pain. Excess of sedation may lead to restlessness, sleeping and snoring, or respiratory depression, which, in the absence of any airway access, may be catastrophic. Therefore, if needed, sedation should be used cautiously and titrated before draping the patient.

Future Directions for Ophthalmic Anesthesia

Today, ophthalmic anesthesia in adults is mainly achieved by regional anesthesia. Research efforts should be directed toward identifying an ideal anesthesia that would provide total akinesia and analgesia, thus allowing all surgical procedures (not only phacoemulsification) to be performed in total security. In terms of efficacy, sub-Tenon's injection appears to be the gold standard. However, most anesthesiologists are unfamiliar with canula techniques that require a 2-hand technique. As regards to complications, needle techniques will probably loose popularity in the future. Topical anesthesia totally prevents anesthesia complications, but some concerns may still be expressed regarding surgical difficulties because of the absence of akinesia. This question should be investigated. A specific local anesthetic jelly mixture for topical anesthesia could be developed. Hyaluronidase, although useful, raises the fear of nonconventional encephalopathy because of its animal origin. Some effort should be made to replace it by another adjuvant.

Conclusion

Eye surgery is among the most often performed surgical procedures requiring anesthesia in developed countries. During the past 20 years, anesthesiologists have assumed a growing role in per-forming eye blocks. Retrobulbar anesthesia is progressively substituted by peribulbar anesthesia. The requirement for dense anesthetic deep block with total akinesia has been greatly lessened by use of phacoemulsification for cataract surgery, giving a place to topical anesthesia. Needle block carries a low but real risk of complications, mainly because of needle misplacement. Correct teaching and training is required to prevent complications. The main patient risk factor is the presence of a myopic staphyloma. A surgical approach to gain access to sub-Tenon's space avoids needle block but does not totally prevent complications. When akinesia and a dense block are required, sub-Tenon's block, performed either by the needle technique or by surgical approach, appears to be the technique of choice.

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